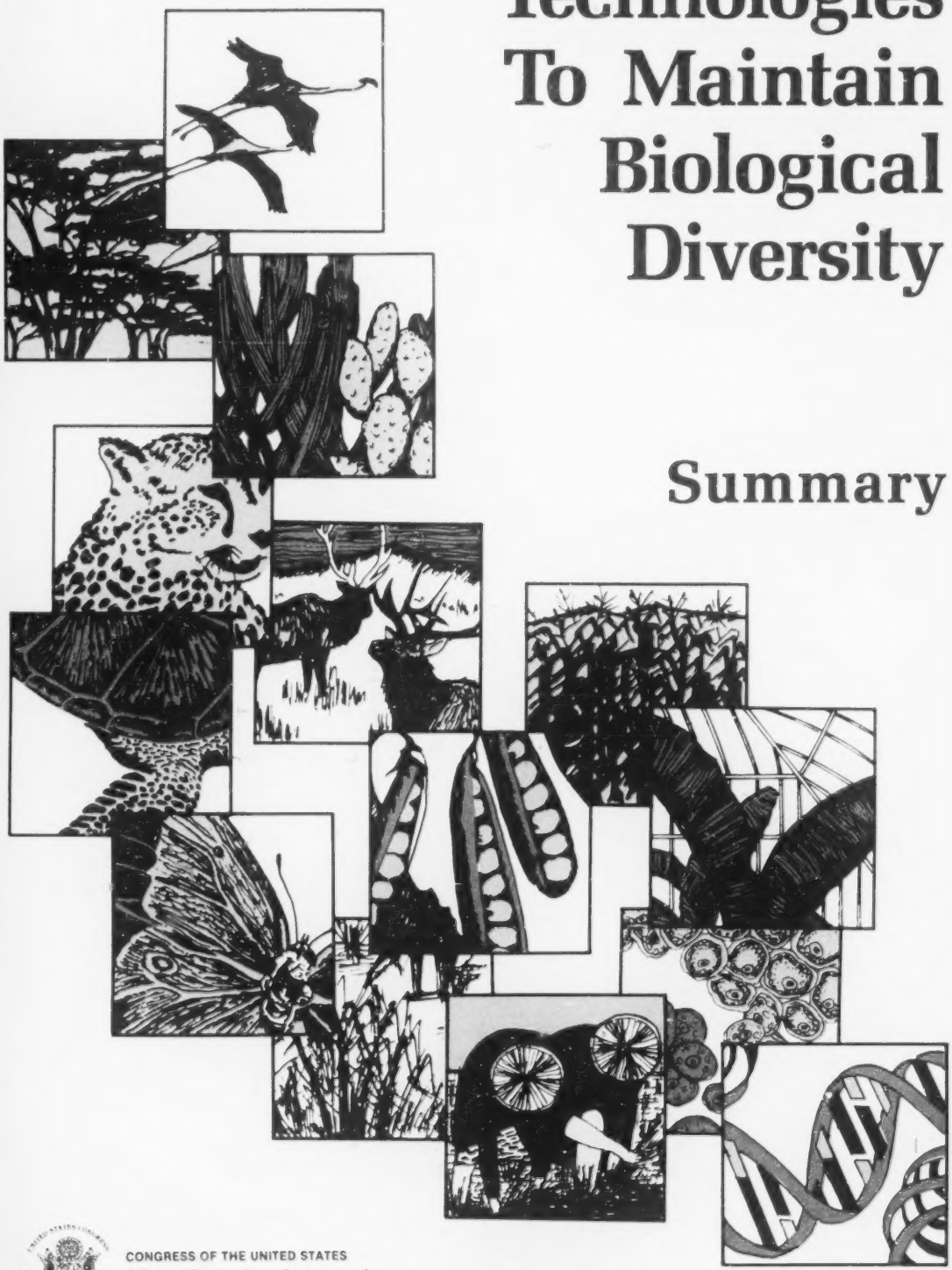
Technologies To Maintain Biological Diversity

Summary



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Foreword

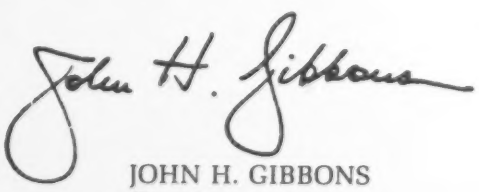
The reduction of the Earth's biological diversity has emerged as a public policy issue in the last several years. Growing awareness of this planetary problem has prompted increased study of the subject and has led to calls to increase public and private initiatives to address the problem.

One major concern is that loss of plant, animal, and microbial resources may impair future options to develop new important products and processes in agriculture, medicine, and industry. Concerns also exist that loss of diversity undermines the potential of populations and species to respond or adapt to changing environmental conditions. Because humans ultimately depend on environmental support functions, special caution should be taken to ensure that diversity losses do not disrupt these functions. Finally, esthetic and ethical motivation to avoid the irreversible loss of unique life forms has played an increasingly major role in promoting public and private programs to conserve particular species or habitats.

Congressional requestors of this assessment include the House Committee on Science, Space, and Technology; Senate Committee on Foreign Relations; and Senate Committee on Agriculture, Nutrition, and Forestry. The House Committee on Foreign Affairs; House Committee on Agriculture; and House Committee on Merchant Marine and Fisheries endorsed the requested study.

The task presented to OTA by these committees was to clarify for Congress the nature of the problems of reduction of the Earth's biological diversity and to set forth a range of policy options available to Congress to respond to various concerns. The principal aim of this assessment is to identify and assess the technological and institutional opportunities and constraints to maintaining biological diversity in the United States and worldwide. Two background papers (*Grassroots Conservation of Biological Diversity in the United States* and *Maintaining Biological Diversity in the United States: Data Considerations*) and a staff paper (*The Role of U.S. Development Assistance in Maintaining Biological Diversity in Developing Countries*) were also prepared in conjunction with this study.

OTA is grateful for the valuable assistance of the study's advisory panel, workgroups, workshop participants, authors of background papers, and the many other reviewers from the public and private sectors who provided advice and information throughout the course of this assessment. As with all OTA studies, the content of this report is the sole responsibility of OTA.



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NOTE: OTA appreciates and is grateful for the valuable assistance and thoughtful critiques provided by the advisory panel members. The panel does not, however, necessarily approve, disapprove, or endorse this report. OTA assumes full responsibility for the report and the accuracy of its contents.

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Technologies To Maintain Biological Diversity

Most biological diversity survives without human interventions to maintain it. But as natural areas become progressively modified by human activities, maintaining a diversity of ecosytems, species, and genes will increasingly depend on intervention by applying specific technologies. A spectrum of technologies are available to support maintenance of biological diversity (defined in box A).

THE PROBLEM

The Earth's biological diversity is being reduced at a rate that is likely to increase over the next several decades. This loss of diversity —measured at the ecosystem, species, and genetic levels—is occurring

Box A.—What Is Biological Diversity?

Biological diversity refers to the variety and variability among living organisms and the ecological complexes in which they occur. Diversity can be defined as the number of different items and their relative frequency. For biological diversity, these items are organized at many levels, ranging from complete ecosystems to the chemical structures that are the molecular basis of heredity. Thus, the term encompasses different ecosystems, species, genes, and their relative abundance.

How does diversity vary within ecosystem, species, and genetic levels? For example,

- **Ecosystem diversity**: A landscape interspersed with croplands, grasslands, and woodlands has more diversity than a landscape with most of the woodlands converted to grasslands and croplands.
- **Species diversity**: A rangeland with 100 species of annual and perennial grasses and shrubs has more diversity than the same rangeland after heavy grazing has eliminated or greatly reduced the frequency of the perennial grass species.
- **Genetic diversity**: Economically useful crops are developed from wild plants by selecting valuable inheritable characteristics. Thus, many wild ancestor plants contain genes not found in today's crop plants. An environment that includes both the domestic varieties of a crop (such as corn) and the crop's wild ancestors has more diversity than an environment with wild ancestors eliminated to make way for domestic crops.

Concerns over the loss of biological diversity to date have been defined almost exclusively in terms of species extinction. Although extinction is perhaps the most dramatic aspect of the problem, it is by no means the whole problem. The consequence is a distorted definition of the problem, which fails to account for many of the interests concerned and may misdirect how concerns should be addressed.

in most regions of the world, although it is most pronounced in particular areas, most notably in the tropics. The principal cause is the increasing conversion of natural ecosystems to human-modified landscapes. Such alterations can provide considerable benefits when the land's capability to sustain development is preserved, but compelling evidence indicates that rapid and unintended reductions in biological diversity are undermining society's capability to respond to future opportunities and needs. Most scientists and conservationists working in this area believe that the problem has reached crisis proportions, although a few people from other fields remain skeptical and maintain that this level of concern is based on exaggerated or insufficient data.

The abundance and complexity of ecosystems, species, and genetic types have defied complete inventory and thus the direct assessment of changes. As a result, **an accurate estimate of the rate of loss is not currently possible.** Determining the number of species that exist,[1] for example, is a major obstacle in assessing the rate of species extinction. But use of biological principles and data on land use conversions have allowed **biologists to deduce that the rate of loss is greater than the rate at which new species evolve.**

Reduced diversity may have serious consequences for civilization. It may eliminate options to use untapped resources for agricultural, industrial, and medicinal development. Crop genetic resources have accounted for about 50 percent of productivity increases and for annual contributions of about $1 billion to U.S. agriculture. For instance, two species of wild green tomatoes discovered in an isolated area of the Peruvian highlands in the early 1960s have contributed genes for marked increase in fruit pigmentation and soluble-solids content currently worth nearly $5 million per year to the tomato-processing industry. Future gains will depend on use of genetic diversity.

Loss of plant species could mean loss of billions of dollars in potential plant-derived pharmaceutical products. About 25 percent of the number of prescription drugs in the United States are derived from plants. In 1980, their total market value was $8 billion. Loss of tropical rain forests, which harbor an extraordinary diversity of species, and loss of desert ecosystems, which harbor genetically diverse vegetation, are of particular concern. Consequences to humans of loss of potential medicines have impacts that go beyond economic benefits. Alkaloids from the rosy periwinkle flower (*Catharantus roseus*), a tropical plant, for example, are used in the successful treatment of several forms of cancer, including Hodgkin's disease and childhood leukemia.

Although research in biotechnology suggests exciting prospects, scientists will continue to rely on genetic resources crafted by nature. For example, new methods of manipulating genetic material enable the isolation and extraction of a desired gene from one plant or organism and its insertion into another. Nature provides the basic materials; science enables the merging of desired properties into new forms or combinations. Loss of diversity, therefore, may undermine societies' realization of the technology's potential.

[1]Approximately 1.7 million species have been identified. Millions more, however, have yet to be discovered. Recent research indicates that species of tropical insects alone could number 30 million.

Photo credit: H. Iltis

A dense stand of *Zea diploperennis* in Sierra de Manantalan, Jalisco, Mexico. This ancient wild relative of corn could be worth billions of dollars to corn growers around the world because of its resistance to seven major diseases plaguing domesticated corn.

Another threatening aspect of diversity loss is the disruption of environmental regulatory functions that depend on the complex interactions of ecosystems and the species that support them.

Diverse wetlands provide productive and protective processes of economic benefit. Millions of waterfowl and other birds of economic value depend on North American wetlands for breeding, feeding, migrating, and overwintering. About two-thirds of the major U.S. commercial fish, crustacean, and mollusk species depend on estuaries and salt marshes for spawning and nursery habitat. Wetlands temporarily store flood waters, reducing flow rates and protecting people and property downstream from flood and storm damage. One U.S. Army Corps of Engineers' estimate places the present value of the Charles River wetlands (in Massachusetts) for its role in controlling floods at $17 million per year. Although placing dollar values on such ecosystem services is problematic and reflects rough approximations, the magnitude of the

economic benefit stresses the importance of these often overlooked values.

Humans also value diversity for reasons other than the utility it provides. Esthetic motivations have played important parts in promoting initiatives to maintain diversity. Cultural factors, as reflected in the way Americans identify with the bald eagle or the American bison or how plants and animals form a fundamental aspect of human artistic expression, illustrate these values.

Forces that contribute to the worldwide loss of diversity are varied and complex. Historically, concern for diversity loss focused on commercial exploitation of threatened or endangered species. Increasingly, however, attention has been focused more on indirect threats that are nonselective and more fundamental and sweeping in scope.

Most losses of diversity are unintended consequences of human activity. Air and water pollution, for example, can cause diversity loss far from the pollution's source. The decline of several fish species in Scandinavia and the near extinction of a salmon species in Canada have been attributed to acidification of lakes due to acid rain. Population growth in itself may not be intrinsically threatening to biological diversity. A populous country like Japan is an example of how a high

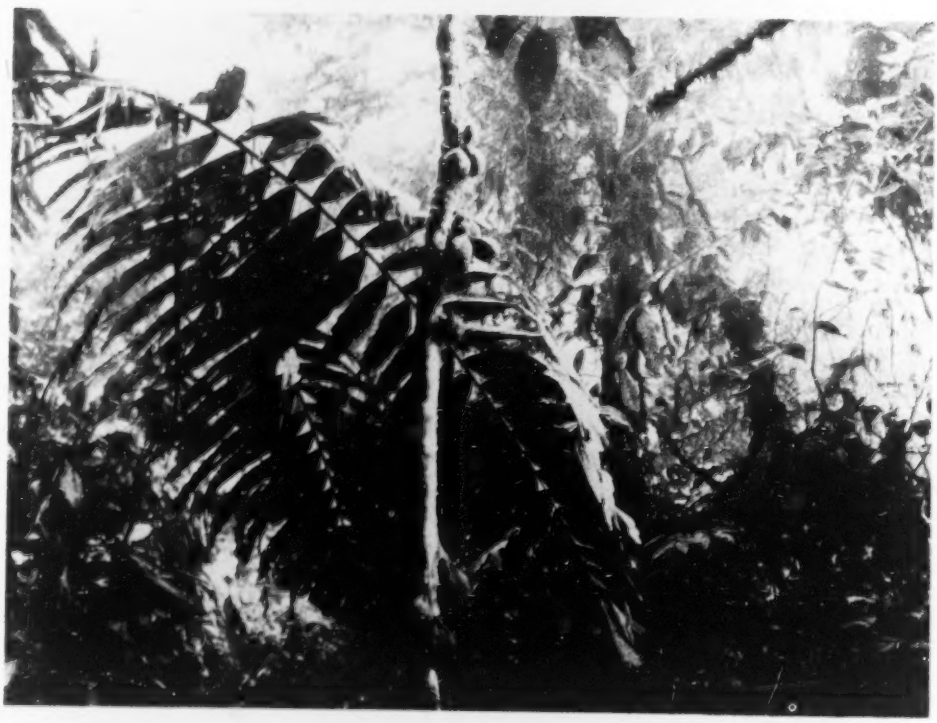

Photo credit: H. Iltis

A foggy, moss- and epiphyte-enshrouded tropical forest in Ecuador is about to be cleared for local agriculture, a main cause of loss of diversity.

standard of living, appropriate government policies, and a predominantly urbanized population can limit the rate of ecosystem disruption. However, when population growth is compounded by poverty, a negative impact is characteristic. In many tropical developing countries, high population growth and the practice of shifting agriculture employed by peasant farmers are considered the greatest threats to diversity.

This report assesses the potential of diversity-maintenance technologies and the institutions developing and applying these technologies. But **maintaining biological diversity will depend on more than applying technologies.** Technologies do not exist to re-create the vast majority of ecosystems, species, and genes that are being lost, and there is little hope that such technologies will be developed in the foreseeable future. Therefore, efforts to maintain diversity must also address the socioeconomic, political, and cultural factors involved.

INTERVENTIONS TO MAINTAIN BIOLOGICAL DIVERSITY

There are two general approaches to maintaining biological diversity. It may be maintained where it is found naturally (onsite), or it may be removed from the site and kept elsewhere (offsite). Onsite maintenance can focus on a particular species or population or, alternatively, on an entire ecosystem. Offsite maintenance can focus on organisms preserved as germplasm or on organisms preserved as living collections. Table 1 lists examples of management systems. These management systems have somewhat different objectives, but all four are necessary components of an overall strategy to conserve diversity. Conservation objectives can be enhanced by investing in any combination of the four systems and by improving links to take advantage of their potential complementariness. The objectives of the management systems are summarized in table 2.

Table 1.—Examples of Management Systems To Maintain Biological Diversity

Onsite		Offsite	
Ecosystem maintenance	Species management	Living collections	Germplasm storage
National parks	Agroecosystems	Zoological parks	Seed and pollen banks
Research natural areas	Wildlife refuges	Botanic gardens	Semen, ova, and embryo banks
Marine sanctuaries	*In-situ* genebanks	Field collections	Microbial culture collections
Resource development planning	Game parks and reserves	Captive breeding programs	Tissue culture collections
← Increasing emphasis on natural processes		Increasing human intervention →	

SOURCE: Office of Technology Assessment, 1986.

Table 2.—Management Systems and Conservation Objectives

Onsite		Offsite	
Ecosystem maintenance	Species maintenance	Living collections	Germplasm storage
Maintain:	Maintain:	Maintain:	Maintain:
• a reservoir or "library" of genetic resources	• genetic interaction between semi-domesticated species and wild relatives	• breeding material that cannot be stored in genebanks	• convenient source of germplasm for breeding programs
• evolutionary potential	• wild populations for sustainable exploitation	• field research and development on new varieties and breeds	• collections of germplasm from uncertain or threatened sources
• functioning of various ecological processes	• viable populations of threatened species	• offsite cultivation and propagation	• reference or type collections as standard for research and patenting purposes
• vast majority of known and unknown species	• species that provide important indirect benefits (for pollination or pest control)	• captive breeding stock of populations threatened in the wild	• access to germplasm from wide geographic areas
• representatives of unique natural ecosystems	• "keystone" species with important ecosystem support or regulating function	• ready access to wild species for research, education, and display	• genetic materials from critically endangered species

SOURCE: Office of Technology Assessment, 1986.

Maintaining plants, animals, and microbes onsite—in their natural environments—is the most effective way to conserve a broad range of diversity. Onsite technologies primarily focus on establishing an area to protect ecosystems or species and on regulating species harvest. To date, the guidelines for optimal design of protected areas are limited, however.

Offsite maintenance technologies are applied to conserving a small but often critical part of the total diversity. Technologies for plants include seed storage, *in vitro* culture, and living collections. Most animals are commonly maintained offsite as captive populations. Cryogenic storage of seeds, *in vitro* cultures, semen, or embryos can improve the efficiency of offsite maintenance and reduce costs.

Microbial diversity is important for both its beneficial and its harmful effects. That is, some microbes (e.g., bacteria and viruses) can present serious threats to human health. By the same token, these organisms are used in a range of beneficial activities, such as for developing vaccines or for treating wastes.

Scientists are hampered in their storage, use, and study of microbial diversity by their inability to isolate most micro-organisms. For those micro-organisms that have been isolated and identified, offsite maintenance is the most cost-effective technique.

Links between onsite and offsite management systems are important to increasing the efficiency and effectiveness of efforts to main-

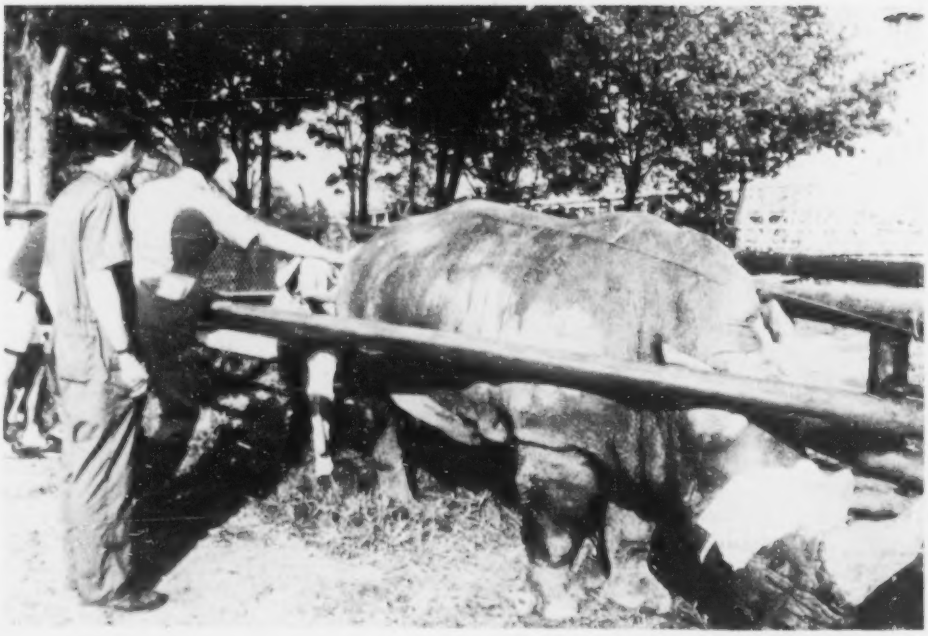

Photo credit: B. Dresser

Staff of the Cincinnati Wildlife Research Federation working on an anesthetized white rhinoceros in an effort to develop embryo transfer techniques. Proper equipment must be developed for collection of embryos from the more common white rhino before it is tested on the endangered black rhino. The white rhino would then be used as a surrogate for embryos from black rhinos.

tain diversity. Some technologies developed for domesticated species, for instance, can be adapted to wild species. Embryo transfer technologies developed for livestock are now being adapted for endangered wild animals.

Determining the efficacy and appropriateness of technologies depends on biological, sociopolitical, and economic factors. Taken together, these factors influence decisionmaking and must be considered in defining objectives for maintaining diversity and for identifying strategies to meet these objectives.

Biological considerations are central to the objectives and choice of systems. Only some diversity is threatened; therefore, the task of maintaining it can focus on elements that need special attention. A biologically unique species (one that is the only representative of an entire genus or family) or a species with high esthetic appeal may be the focus of intensive conservation management.

Political factors also influence conservation objectives and management systems. Commitments of government resources, policies, and programs determine the focus of attention, and to a large extent, such commitments reflect public interests and support. For example, a disproportionate share of U.S. resources is devoted to programs for a few of the many endangered species. Substantial sums have been spent in 11th-hour efforts to save the California condor and the black-footed ferret, while other endangered organisms such as invertebrate species receive little attention.

The applicability of management systems also depends on economic factors. Costs of alternative management systems and the value of resources to be conserved may be relatively clear in the case of genetic resources. For example, the benefits of plant breeding programs compared with the cost of seed maintenance justify germplasm storage technologies. However, cost-benefit analysis is more difficult when benefits are diffuse and accrue over a long period. And onsite maintenance programs compete with other interests for land, personnel, and funds.

Success in maintaining biological diversity depends largely on institutions that develop and apply the various technologies. Within the United States, a variety of laws in addition to public and private programs address various aspects of diversity conservation. But while some aspects of diversity are covered, other aspects are ignored. Table 3 lists major Federal mandates pertinent to diversity maintenance.

Because U.S. interest in biological diversity extends beyond its borders, the United States subscribes to a number of international conservation laws and supports programs through bilateral and multilateral assistance channels. However, many of these programs have too little support to be effective in resolving internationally important problems.

Both domestic and international institutions deal with aspects of diversity. Some focus attention exclusively on maintaining certain agricultural crops, such as wheat, and others focus on certain wild species, such as whales and migratory waterfowl. A shift has occurred in re-

Table 3.—Federal Laws Relating to Biological Diversity Maintenance

Common name	Resource affected	U.S. Code
Onsite diversity mandates:		
Lacey Act of 1900	wild animals	16 U.S.C. 667, 701
Migratory Bird Treaty Act of 1918	wild birds	16 U.S.C. 703 et seq.
Migratory Bird Conservation Act of 1929	wild birds	16 U.S.C. 715 et seq.
Wildlife Restoration Act of 1937 (Pittman-Robertson Act)	wild animals	16 U.S.C. 669 et seq.
Bald Eagle Protection Act of 1940	wild birds	16 U.S.C. 668 et seq.
Whaling Convention Act of 1949	wild animals	16 U.S.C. 916 et seq.
Fish Restoration and Management Act of 1950 (Dingell-Johnson Act)	fisheries	16 U.S.C. 777 et seq.
Anadromous Fish Conservation Act of 1965 (Public Law 89-304)	fisheries	16 U.S.C. 757a-f
Fur Seal Act of 1966 (Public Law 89-702)	wild animals	16 U.S.C. 1151 et seq.
Marine Mammal Protection Act of 1972	wild animals	16 U.S.C. 1361 et seq.
Endangered Species Act of 1973 (Public Law 93-205)	wild plants and animals	7 U.S.C. 136 16 U.S.C. 460, 668, 715, 1362, 1371, 1372, 1402, 1531 et seq.
Magnuson Fishery Conservation and Management Act of 1977 (Public Law 94-532)	fisheries	16 U.S.C. 971, 1362, 1801 et seq.
Whale Conservation and Protection Study Act of 1976 (Public Law 94-532)	wild animals	16 U.S.C. 915 et seq.
Fish and Wildlife Conservation Act of 1980 (Public Law 96-366)	wild animals	16 U.S.C. 2901 et seq.

Table 3.—Federal Laws Relating to Biological Diversity Maintenance—Continued

Common name	Resource affected	U.S. Code
Salmon and Steelhead Conservation and Enhancement Act of 1980 (Public Law 96-561)	fisheries	16 U.S.C. 1823 et seq.
Fish and Wildlife Coordination Act of 1934	terrestrial/aquatic habitats	16 U.S.C. 694
Fish and Game Sanctuary Act of 1934	sanctuaries	16 U.S.C. 694
Historic Sites, Buildings, and Antiquities Act of 1935	natural landmarks	16 U.S.C. 461-467
Fish and Wildlife Act of 1956	wildlife sanctuaries	15 U.S.C. 713 et seq. 16 U.S.C. 742 et seq.
Wilderness Act of 1964 (Public Law 88-577)	wilderness areas	16 U.S.C. 1131 et seq.
National Wildlife Refuge System Administration Act of 1966 (Public Law 91-135)	refuges	16 U.S.C. 668dd et seq.
Wild and Scenic Rivers Act of 1968 (Public Law 90-542)	river segments	16 U.S.C. 1271-1287
Marine Protection, Research and Sanctuaries Act of 1972 (Public Law 92-532)	coastal areas	16 U.S.C. 1431-1434 33 U.S.C. 1401, 1402, 1411-1421, 1441-1444
Federal Land Policy and Management Act of 1976 (Public Law 94-579)	public domain lands	7 U.S.C. 1010-1012 16 U.S.C. 5, 79, 420, 460, 478, 522, 523, 551, 1339 30 U.S.C. 50, 51, 191 40 U.S.C. 319 43 U.S.C. 315, 661, 664, 665, 687, 869, 931, 934-939, 942-944, 946-959, 961-970, 1701, 1702, 1711- 1722, 1731-1748, 1753, 1761-1771, 1781, 1782
National Forest Management Act of 1976 (Public Law 94-588)	national forest lands	16 U.S.C. 472, 500, 513, 515, 516, 518, 521, 576, 581, 1600, 1601-1614
Public Rangelands Improvement Act of 1978 (Public Law 95-514)	public domain lands	16 U.S.C. 1332, 1333 43 U.S.C. 1739, 1751-1753, 1901-1908
Offsite diversity mandates:		
Agricultural Marketing Act of 1946 (Research and Marketing Act)	agricultural plants and animals	5 U.S.C. 5315 7 U.S.C. 1006, 1010, 1011, 1924-1927, 1929, 1939-1933, 1941-1943, 1947, 1981, 1983, 1985, 1991, 1992, 2201, 2204, 2212, 2651- 2654, 2661-2668 16 U.S.C. 590, 1001-1005 42 U.S.C. 3122
Endangered Species Act of 1973 (Public Law 93-205)	wild plants and animals	7 U.S.C. 136 16 U.S.C. 460, 668, 715, 1362, 1371, 1372, 1402, 1531 et seq.
Forest and Rangeland Renewable Resources Research Act of 1978 (Public Law 95-307)	tree germplasm	16 U.S.C. 1641-1647

NOTE: Laws enacted prior to 1957 are cited by Chapter and not Public Law number.

SOURCE: Office of Technology Assessment, 1986.

cent years from the traditional species protection approach to a more encompassing ecosystem maintenance approach.

Much of the work important to diversity maintenance is done in isolation and is too disjunct to address the full range of concerns. And some concerns receive little or no attention. For example, the objectives of the U.S. Department of Agriculture's National Plant Germplasm System (NPGS) place primary emphasis on economic plants and little emphasis on non-crop species. Similarly, programs to protect endangered wild species direct attention away from species that are threatened but not listed as endangered. The lack of connections between programs is another institutional constraint. Linkages help define common interests and areas of potential cooperation—important steps in defining areas of redundancy, neglect, and opportunity.

THE ROLE OF CONGRESS

Given the implications and irreversible nature of biological extinction, policymakers must continue to address the problem of diminishing biological diversity. A significant increase in attention and funding in this area seems consistent with U.S. interests, in view of the benefits the United States currently derives from biological diversity and the advances that biotechnology might achieve given a diversity of genetic resources. In addition, enough information exists to define priorities for diversity maintenance and to provide a rationale for taking initiatives now, although further research and critical review of the nature and extent of diversity loss are also warranted.

OTA has identified options available to Congress. These options are discussed under five major issues:

1. strengthening the national commitment,
2. increasing the Nation's ability to maintain biological diversity,
3. enhancing the knowledge base,
4. supporting international initiatives, and
5. addressing loss of biological diversity in developing countries.

For each issue, alternative or complementary options are presented. These range from legislative initiatives to programmatic changes within Federal agencies. Options also define opportunities to cultivate or support private sector initiatives. In a number of areas, however, success will depend on increased or redirected commitments of resources. Table 4 provides a summary of policy issues and options.

Strengthen the National Commitment To Maintain Biological Diversity

The national commitment to maintain biological diversity could be strengthened. Despite society's reliance on biological resources for sustenance and economic development, loss of diversity has yet to emerge as a major concern among decisionmakers. About 2 percent of the national budget is spent on natural resources-related programs, which include diversity-conservation programs as one subset.

Table 4.—Summary of Policy Issues for Congressional Action Related to Biological Diversity Maintenance

Issue	Finding	Options
Strengthen national commitment	*Adopt a comprehensive approach to maintaining biological diversity*	Establish a national biological diversity act Prepare a national conservation strategy Amend appropriate legislation of Federal agencies
	Increase public awareness of biological diversity issues	Establish a national conservation education act Amend the International Security and Development Cooperation Act
Increase ability to maintain biological diversity	*Improve research, technology development and application*	Direct National Science Foundation to establish a conservation biology program Establish a national endowment for biological diversity
	Fill gaps and inadequacies in existing programs	Provide sufficient funding for existing maintenance programs Improve link between onsite and offsite programs Establish new programs to fill specific gaps in current efforts
Enhance knowledge base	*Improve data collection, maintenance, and use*	Establish a clearinghouse for biological data Enhance existing natural heritage network of conservation data centers
Support international initiatives	*Provide greater leadership in the international arena*	Increase support of existing international programs Continue oversight hearings of multilateral development banks' activities
	Promote the exchange of genetic resources	Examine U.S. options on international exchange of germplasm Amend the Export Administration Act to affirm U.S. commitment to free exchange of germplasm
Address loss in developing countries	*Amend Foreign Assistance Act*	Adopt broader definition of biological diversity in Foreign Assistance Act
	Enhance capability of the Agency for International Development	Direct AID to adopt strategic approach to diversity conservation Increase AID staffing of personnel with environmental training
	Establish alternative funding sources for biological diversity projects	Create special account for natural resources and the environment Apply more Public Law 480 funds to effort

SOURCE: Office of Technology Assessment, 1987.

A number of government and private programs address maintenance of biological diversity, but most programs have objectives too narrowly defined to address the broad scope of biological diversity concerns. Nor do the ad hoc programs use coordination and cooperation to build a systematic approach to tackle the issue. State and private efforts fill

some gaps in Federal programs, but they do not provide a comprehensive national commitment and thus leave many aspects of the problem uncovered.

Federal agencies, for example, coordinate the onsite conservation activities mentioned specifically in Federal species protection laws, such as those under the authority of the Endangered Species Act of 1973 (Public Law 93-205), but no formal institutional mechanism exists for the thousands of plant, animal, and microbial species not listed as threatened or endangered. Mandates for offsite conservation are equally vague about which species they are to consider. For example, the Research and Marketing Act of 1946 is intended to "promote the efficient production and utilization of products of the soil" (7 U.S.C.A. 427), but it is interpreted narrowly by the Agricultural Research Service (ARS) to mean economic plant species and varieties. Thus, little government attention has been given to conserving the multitude of wild plant species offsite. Even less attention is given to offsite conservation of domesticated and wild animals.

FINDING 1: A comprehensive approach is needed to arrest the loss of biological diversity. Significant gaps in existing programs could be identified with such an approach, and the resources of organizations concerned with the issue could be better allocated. Improved coordination could create opportunities to enhance effectiveness and efficiency of Federal, State, and private programs without interfering with achievement of the programs' goals.

The broad scale of the problem of diversity loss necessitates innovative solutions. Various laws and programs of Federal, State, and private organizations already provide the framework for a concerted comprehensive approach. At this time, however, few of these programs state maintenance of biological diversity as an explicit objective. As a result, diversity is given cursory attention in most conservation and resource management programs. Some of them, such as the Endangered Species Program, address diversity more directly but are concerned with only one facet of the problem. Duplication of efforts, conflicts in goals, and gaps in geographic and taxonomic coverage are consequences.

To resolve this institutional problem, a comprehensive approach to maintaining biological diversity is needed. The implication is not that all programs should address the full range of approaches; rather, organizations should view their own programs within the broader context of maintaining diversity and should coordinate their programs with those of other organizations. Programs and organizations would thereby benefit from one another. Gaps could be identified and eventually filled, and duplicate efforts could be reduced. And organizations could improve efficiency by taking the responsibilities for which they are best suited. Moreover, financial support for diversity maintenance could be more effectively distributed. A step in this direction has been taken in recent initiatives, but congressional commitment to such an endeavor is necessary to ensure that efforts will be made to achieve a comprehensive approach to maintaining biological diversity.

Option 1.1: Enact legislation that recognizes the importance of maintaining biological diversity as a national objective.

Current legislation addressing the loss of biological diversity in the United States is largely piecemeal. Although many Federal laws affect conservation of diversity, few refer to it specifically. The National Forest Management Act of 1976 is the only legislation that mandates the conservation of a "diversity of plant and animal communities," but it offers no explicit direction on the meaning and scope of diversity maintenance.

Consequently, existing Federal programs focus on sustaining specific ecosystems, species, or gene pools, or on protecting endangered wildlife. Species protection laws authorize Federal agencies to manage specific animal populations and their habitats. Habitat protection laws authorize the acquisition or designation of habitats under Federal stewardship. Federal laws for offsite maintenance of plants authorize the collection and genetic development of plant species that demonstrate potential economic value.

The Endangered Species Act authorizes protection of species considered threatened or endangered in the United States. However, listing endangered species does not eliminate the problem; efforts are hampered by slow listing procedures, by emphasis on vertebrate animals at the expense of plants and invertebrates, and by concerns about conflicts that endangered status might create.

Congress could pass a National Biological Diversity Act to endorse the importance of the issue and to provide guidance for a comprehensive approach. Such an act could explicitly state maintenance of diversity as a national goal, establish mechanisms for coordinating activities, and set priorities for diversity conservation. A national policy could bring about cooperation among Federal, State, and private efforts, help reduce conflicting activities, and improve efficiency and cost-effectiveness of programs.

To be effective, a new act would require a succinct definition of biological diversity and explicit goals for its maintenance. Otherwise, ambiguities would lead to misinterpretation and confusion. Diversity, for example, could be interpreted broadly when authorities and funding are being sought and narrowly when responsibilities are assigned. Identifying goals is likely to be a long and politically sensitive process. Decisionmakers and the public will have to determine if conserving maximum diversity is the desirable goal. Finally, to be effective, the law must have public support and adequate resources, or it would simply provide a false reassurance that something is being done.

Option 1.2: Develop a National Conservation Strategy for U.S. biological resources.

Another means of comprehensively addressing diversity maintenance is to develop a National Conservation Strategy (NCS). This strategy could be developed in conjunction with, or in lieu of, a mandate as suggested in the preceding option. The process would initiate coordination of Fed-

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eral programs. Program administrators could identify measures to reduce overlap and duplication, to minimize jurisdictional problems, and to develop new initiatives.

A national strategy could minimize potential competition, conflict, and duplication among programs in the private and public sectors. In addition, preparation of an NCS would strengthen efforts to promote NCSs in other countries. Some 30 countries (mostly developing countries, but also including Canada and the United Kingdom) have initiated concrete steps to prepare an NCS. U.S. action might reinforce the momentum for NCSs in other countries.

Congress could establish an independent commission to prepare the NCS. Members of the commission could serve part-time and be provided a budget for meetings and administrative support. The commission could include representatives from government, academia, and the private sector. The Public Land Law Review Commission and the National Water Commission are potential models.

In developing a national strategy, such a commission could do the following:

- assess the adequacy of existing programs to conserve biological diversity;
- formulate a national policy on maintenance of biological diversity;
- identify measures required to implement the policy, any obstacles to such measures, and the means to overcome those obstacles;
- determine how biological diversity maintenance relates to other conservation and development interests; and
- include a public consultation and information program to build a consensus on the content of the national conservation strategy.

Another way to prepare a strategy is to tap the resources of an established government agency. An appropriate body could be the Council for Environmental Quality (CEQ), which is part of the Office of the President. Created by the National Environmental Policy Act of 1969, CEQ already prepares annual reports for the President on the state of the environment. In doing so, it uses the services of public and private agencies, organizations, and individuals and hence has the experience and authority to bring together various interest groups and expertise. On the other hand, CEQ, though fully staffed in the 1970s with a range of environmental experts, now has only a small staff of administrators, Coordinating and guiding the substantive development of an NCS is thus beyond the council's current capacity except through use of consultants.

Because the success of an NCS depends on participation of a broad spectrum of interest groups, its preparation could be a daunting prospect. The number, size, and nature of U.S. Government agencies and the different sectors involved could make preparation and implementation of a strategy difficult.

Option 1.3: Amend the legislation of Federal agencies to make maintenance of biological diversity an explicit consideration in their activities.

Yet another means for Congress to encourage a comprehensive approach is to make maintenance of biological diversity an explicit consideration of Federal agencies' activities. A number of Federal programs affecting biological diversity are scattered throughout different agencies, but the lack of coordination results in inefficient and inadequate coverage of the problem.

These amendments could involve the creation of new programs, or they could lead to modified objectives for existing programs. In either case, the amendments should redirect certain policies, consolidate conservation efforts, and provide criteria for settling conflicts. An amendment for Federal land managing agencies, for example, could require that these agencies make diversity conservation a priority in decisions relating to land acquisition, disposal, and exchange.

Such amendments would probably be resisted by individual Federal agencies, which could argue that they are already maintaining diversity and do not need more explicit direction from Congress. In addition, agencies could argue that they could not increase their activities without new appropriations; otherwise, the quality of existing work could be compromised.

Before such amendments are written, a systematic review of all Federal resource legislation will be needed to determine how existing statutory mandates and programs affect the conservation of diversity and how they complement or contradict one another, and to designate which programs are most in need of revision. Such a complex review will take time and money and is likely to be opposed by agencies.

FINDING 2: Because maintenance of biological diversity is a long-term problem, policy changes and management programs must be long lasting to be effective. But, such policies and programs must be understood and accepted by the public, or they will be replaced or overshadowed by shorter term concerns. Conveying the importance of biological diversity requires formulating the issue in terms that are technically correct yet understandable and convincing to the general public. To undertake the initiative will require not only biologists but also social scientists and educators working together.

Diversity loss has not captured public attention for three reasons. First, it is a complex concept to grasp. Rather than attempt to improve understanding of the broad issue, organizations soliciting support have made emotional appeals to save particular appealing species or spectacular habitats. This approach is effective in the short-term, but it keeps the constituency and the scope of the problem narrow. Second, the more

pervasive threats to diversity, such as loss of habitat or diminished genetic bases for agricultural crops, are gradual processes rather than dramatic events. Third, most benefits of maintaining diversity are often diffuse, unpriced, and reaped over the long-term, resulting in relatively low economic values being assigned to the goods and services provided. The benefits of diversity, therefore, are not presented concretely and competitively with other issues. Consequently, the public and policymakers generally lack an appreciation of possible consequences of diversity loss.

Notwithstanding these difficulties, environmental quality has been a major public policy concern since the 1970s, and it remains firmly entrenched in the consciousness of the American public. A 1985 Harris poll, for example, indicated that 63 percent of Americans place greater priority on environmental clean-up than on economic growth. And because stewardship of the environment includes maintaining diversity, this predisposition of Americans could be built on to develop support for diversity maintenance programs.

Biological diversity benefits a variety of special interest groups; its potential constituency is enormous but fragmented. It includes, for example, the timber and fishing industries as well as farmers, gardeners, plant breeders, animal breeders, recreational hunters, indigenous peoples, wilderness enthusiasts, tourists, and all those who enjoy nature. The combined interests of all these groups could cultivate a national commitment to maintaining biological diversity, if properly orchestrated.

Option 2.1: Promote public education about biological diversity by establishing a National Conservation Education Act.

Just as sustaining support to enhance environmental quality required public education programs, so too will a concerted national effort to conserve biological diversity require a strong public education effort. A National Conservation Education Act could be patterned after the Environmental Education Act of 1971 (Public Law 91-516), which authorized the U.S. Commissioner of Education to establish education programs that would encourage understanding of environmental policies.[2]

A new act could support programs and curricula that promote, inter alia, the importance of biological diversity to human welfare. A small grants program could support research and pilot public education projects. Funds could be made available to evaluate methods for curricula development, dissemination of curricula, teacher training, ecological study center design, community education, and materials for mass media programs. The act could support interaction among existing State environmental education programs, such as those in Wisconsin and Minnesota, and encourage the establishment of new programs in other States. The Department of Education could provide consulting services to school districts to develop education programs.

[2]This act was repealed by Public Law 97-35 in 1981, and the Department of Education has requested no funds for environmental education in its 1987 budget.

An attempt to establish additional environmental education legislation might be opposed because of the trend to reduce the Federal Government's role in education and to rely more on State and private sector initiatives. Therefore, it could be argued that private organizations, such as the Center for Environmental Education, are the appropriate agents to increase public awareness. It could also be argued that Federal agencies are already educating the public about environmental issues and could easily include biological diversity in their programs without new legislation. Besides, new legislation would require additional appropriations, and in a time of budgetary constraints, funding requests for conservation education programs would probably be opposed.

Option 2.2: Amend the International Security and Development Act of 1980 to increase the awareness of the American public about international diversity conservation issues that affect the United States.

Even more difficult than increasing the public's awareness of domestic issues in biological diversity is increasing their awareness of the relevance of diversity loss in other countries. In addition to humanitarian and ethical reasons, maintaining diversity in other countries benefits the United States by sustaining biological resources needed for American agriculture, pharmacology, and biotechnology industries, and by sustaining natural resources necessary for commerce and economic development.

Maintaining biological diversity for security and quality of life enhancement, and the wisdom of incorporating such issues into U.S. foreign assistance efforts, are justification for Congress to promote public awareness of the global nature of the problem.

Mechanisms for educating the public about such international issues are already in place. Specifically, several nongovernmental organizations (NGOs) have international conservation operations. A coalition of these groups actively participated in the U.S. Interagency Task Force on biological diversity that formulated the *U.S. Strategy on the Conservation of Biological Diversity in Developing Countries.* As a group, they have identified public education as a major role for NGOs.

The grassroots approach of NGOs is conducive to heightening public awareness, as illustrated by the support for programs to alleviate famine in Africa. Recognizing the potential of NGOs to stimulate public awareness and discussion of the political, economic, technical, and social factors relating to world hunger and poverty, Congress amended the International Security and Development Cooperation Act of 1980 with Title III, Section 316, to further the goals of Section 103.[3]

[3]Sec. 103, entitled "Agriculture, Rural Development and Nutrition," recognizes that the majority of people in developing countries live in rural areas and close to subsistence. It authorizes the President to furnish assistance to alleviate hunger and malnutrition, enhance the capacity of rural people, and to help create productive on- and off-farm employment. Sec. 316 encourages private and voluntary organizations to facilitate widespread public discussion, analysis, and review of the issues of world hunger. It especially calls for increased public awareness of the political, economic, technical, and social factors affecting hunger and poverty.

This amendment provides NGOs with Biden-Pell matching grants to support programs that educate U.S. citizens about the links between American progress and progress in developing countries. The Agency for International Development (AID) has used these grants mainly to promote American understanding of the problems faced by farmers in developing countries and how resolution of those problems benefits Americans. Recently, use of the grants has been broadened to include public education on international environmental issues. *Congress could encourage this action by expressing its approval during oversight hearings or by further amending the International Security and Development Cooperation Act specifically to authorize support for education programs on environmental issues, especially on biological diversity.*

Increase the Nation's Ability To Maintain Biological Diversity

The ability to maintain biological diversity depends on the availability of applicable technologies that are useful and affordable and on programs designed to apply these technologies to clearly identified needs. Thus, increasing the Nation's ability to maintain diversity will require an improved system for identifying needs and for developing or adapting technologies and programs to address these needs.

At present, technologies and programs are not sufficient to prevent further erosion of biological resources. The problem of diversity loss has been recognized relatively recently, and scientists have just begun to focus attention on it. Progress is slow partly because basic research is poorly funded, and institutions are not organized to follow-up basic research with synthesis of results, technology development, and technology transfer. The last reason implies a need for goal-oriented research.

Many of the Nation's current research programs related to biological diversity do not have a goal-oriented approach. Institutional reward systems and prestige factors deter many scientists from engaging in work that translates basic science into practical tools. Several Federal agencies support basic biology and ecology research, but too little support exists for synthesis of the research into technologies.

Improved links between research and management systems, that is, technology transfer, can increase efficiency, effectiveness, and ability for maintaining diversity. For example, understanding how to maintain and propagate wild endangered species has been preceded by efforts to maintain domestic species. Perhaps the most dramatic linkage is embryo transfer technology developed for livestock now being adapted for endangered wildlife. Similarly, plant storage technologies developed for agricultural varieties, such as cryogenics and tissue culture, may be valuable tools for maintaining rare or threatened wild plant species, even if only as backup collections.

FINDING 3: Current technologies are insufficient to prevent further erosion of biological resources. Thus, increasing the Nation's ability to maintain biological diversity will require acceleration of basic research as well as research in development and implementation of resource management technologies.

Most resource management technologies were developed to meet narrow needs. Onsite technologies are generally directed toward a particular population or species, and offsite technologies are generally directed toward organisms of economic importance. This restricted focus of basic research and technology development is not sufficient to meet the broad goal of maintaining diversity, given the number of species involved and the time and funds available.

To accelerate research and application of diversity-conserving technologies, a shift of emphasis is necessary in research funding. Agencies that fund or conduct research (e.g., the National Science Foundation (NSF) and the Agricultural Research Service of the USDA) generally do not focus on applying research to technology development; they mostly are oriented toward supporting basic research. For example, research funds are available for descriptive studies of population genetics but not for studies on applications of genetic theory to onsite population management. Scientists are rewarded for research that tests hypotheses relatively quickly and for publication of research results in academic journals. These incentives discourage broad, long-term studies and neglect analyzing research results to develop technology systems.

Another avenue to increasing the ability to maintain diversity is to encourage development and implementation of programs by private organizations. Although many private efforts are not defined in terms of diversity conservation per se, activities to conserve aspects of diversity (i.e., ecosystems, wild species, agricultural crops, and livestock) have had significant impact. These efforts are not likely to replace public or national programs, but they could be an integral part of the Nation's attempt to maintain its biological heritage.

Option 3.1: Direct the National Science Foundation to establish a program for conservation biology.

The field of conservation biology seeks to develop scientific principles and then apply those principles to developing technologies for diversity maintenance. Recently, the development of this discipline has gained momentum through the establishment of study programs at some universities and the formation of a Society of Conservation Biology, with its own professional journal. Nevertheless, conservation biology is only beginning to be recognized by the academic community as a legitimate discipline. No research funds support it explicitly. Therefore, few scientists can afford to conduct innovative conservation biology research.

Current funding for research and technology development in conservation biology is negligible, in large part because NSF considers it to be too applied, while other government agencies consider it to be too theoretical. *Congress could encourage scientists to specialize in conservation biology by establishing within NSF a separate conservation biology research program that would support the broad spectrum of basic and applied research directed at developing and applying science and technology to biological diversity conservation.*

To enhance interprogram links, this program could fund studies that integrate onsite and offsite methods—at the ecosystem, species, and genetic levels. Such a program would also bring much needed national recognition, research funding, and scientific expertise to the field of conservation biology. This support would accelerate its acceptance and growth within the scientific community and the development of new principles and technology.

Current statutory authority of NSF would cover such a program. NSF programs are supposed to support both basic and applied scientific research relevant to national problems involving public interest; the maintenance of biological diversity is such a problem.

NSF might resist establishing such a program, because NSF views conservation biology as a mission-oriented activity. Since conservation biology includes technology development, NSF might view a diversity program as a potentially dangerous precedent to its role as the Nation's major supporter of basic research. Furthermore, NSF might argue that a new research program is not needed because its Division of Biotic Systems and Resources already supports about 60 basic research projects that address biological diversity issues. These projects, however, largely ignore the social, economic, political, and management aspects of biological diversity, and conservation is usually of secondary importance to the projects.

An alternative to establishing an NSF program could be to enhance or redirect existing programs in other agencies to promote research in diversity maintenance. The Institute of Museum Services (IMS), a federally sponsored program, already provides a small amount of funding for research on both onsite and offsite diversity maintenance. IMS supports activities from ecosystem surveys to captive breeding. However, the principal focus of IMS is public education, and its small budget is spread over a wide range of programs (e.g., art museums and historic collections), many of which are unrelated to biological research. Thus, IMS would be unable, with its current funding, to take greater responsibility for technology development; new appropriations would be necessary.

Development and application of diversity-conserving technologies could also be funded through other Federal agencies' research programs. *Congress could encourage appropriate agencies to increase emphasis on development of diversity technology.* One source of funding is through the USDA Competitive Research Grants Office (CRGO). At present, the only research related to genetic resources funded by USDA-CRGO is in the area of molecular genetics. As a result, little funding

is available for scientists seeking to conduct research in germplasm preservation, maintenance, evaluation, and use.

Option 3.2: Establish a National Endowment for Biological Diversity.

Congress could establish a National Endowment for Biological Diversity to fund private organizations in research, education, training, and maintenance programs that support the conservation of biological diversity. Currently, no central institution funds such efforts.

Efforts, however piecemeal, of private organizations and individuals are currently making significant contributions to the maintenance of the Nation's diversity. Frequently, they undertake activities that Federal and State agencies cannot or do not address. Through their special interests, these groups as a whole also play a major role in raising public awareness and concern about the loss of diversity. In this way, they increase the constituency backing government programs that maintain natural areas as well as those that collect and safeguard genetic resources.[4] Funding, however, is a major constraint for nearly all these private activities. A program of small grants with a ceiling of perhaps $25,000 per grant (similar to the grants awarded by IMS) could make a substantial contribution to the shoestring budgets of these small organizations and thus enhance national efforts to maintain biological diversity at relatively little cost.

A National Endowment for Biological Diversity could provide funds to private organizations to carry out the following:

- support research and application of methods to conserve biological diversity,
- award fellowships and grants for training,
- foster and support education programs to increase public understanding and appreciation of biological diversity, and
- buy necessary equipment such as small computers.

This national endowment could be created by amending the act that authorizes other national endowment (of arts and humanities) programs. The National Foundation on Arts and Humanities Act of 1965 (Public Law 89-209) declares that the encouragement and support of national progress is of Federal concern and supports scholarships, research, the improvement of education facilities, and encouragement of greater public awareness.

A major constraint to establishing an endowment is the availability of funds during this period of severe budget cutbacks. However, even a small program could significantly encourage private sector initiatives in diversity maintenance. Thus, the total amount needed for such an endowment could be modest, and it might be feasible to use only startup funds and a partial contribution from the Federal Government and raise the remainder of the endowment from private sector contributions.

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[4]For further discussion, see U.S. Congress, Office of Technology Assessment, *Grassroots Conservation of Biological Diversity in the United States*, Background Paper #1, OTA-BP-F-38 (Washington, DC: U.S. Government Printing Office, February 1986).

FINDING 4: Many Federal agencies sponsor diversity maintenance programs that are well designed but not fully effective in achieving their objectives because of inadequate funding and personnel, lack of links to other programs, or lack of complementary programs in related fields.

Much is already being done to maintain certain aspects of diversity in the United States, but efforts are constrained by shrinking budgets and personnel. And as noted earlier, the programs addressing biological diversity are piecemeal rather than comprehensive or strategic. Whether or not Congress chooses to promote a comprehensive strategy for diversity maintenance, specific attention is needed to remedy the major gaps and inadequacies in existing programs.

Option 4.1: Provide increased funding to existing programs for maintenance of diversity.

A number of governmental programs for diversity maintenance already exist, some because of congressional mandates. Yet the full potential of some of those programs has not been realized because funding is insufficient. Two such programs are the National Plant Germplasm System (NPGS) and the Endangered Species Program, though others would also benefit from higher levels of funding.

The NPGS of the Agricultural Research Service has functioned for years on severely limited funds and, consequently, is in danger of losing some of the storehouse of plant germplasm. This desperate situation is best illustrated by the National Seed Storage Laboratory (NSSL), which is expected to exceed its storage capacity in 2 years. At the same time, NSSL is being pressured to increase collection and maintenance of wild plant germplasm. NPGS is attempting to respond to various criticisms about its effectiveness, but progress has been slow because of lack of funds and personnel. The 1986 appropriation for germplasm work is approximately $16 million, but to support current programs adequately would cost about $40 million (1981 dollars) annually.

Similarly underfunded and understaffed is the Endangered Species Program of the Fish and Wildlife Service. A review of this program shows a substantial and growing backlog of important work. The rate of proposing species for the threatened and endangered list is so slow that a few candidates (e.g., Texas Henslow's sparrow) may have become extinct while awaiting listing. Critical habitat has been determined for only one-fourth of the listed species, and recovery plans have been approved for only some of the listed species.

Congress could provide adequate funding for these and other programs to achieve their goals in maintaining diversity. NPGS could, as a result, increase the viability of stored germplasm through more frequent testing and regeneration of accessions. NSSL could increase its efficiency by expanding storage capacity and adopting new technologies. For example, cryogenic storage could be used to reduce maintenance cost and space, thereby enabling a larger collection of germplasm. Likewise, the Endangered Species Program would be able to assess can-

didate species faster and to develop and implement recovery plans for those already listed species.

Option 4.2: Amend appropriate legislation to improve the link between onsite and offsite maintenance programs.

Coordination between onsite and offsite programs is inadequate. *By amending appropriate legislation, Congress could encourage the complementary use of onsite and offsite technologies.* For example, the Endangered Species Act could be amended to encourage use of captive breeding and propagation techniques. Such methods have been used with some endangered species, such as the red wolf, whooping crane, and grizzly bear. But for other species, such as the California condor, black-footed ferret, and dusky seaside sparrow, recovery plans do not exist or were too long delayed. Recovery plans for endangered species seldom include the use of offsite techniques, partly because captive breeding and propagation are outside the scope of natural resource management agencies; rather, they are in the province of zoos, botanic gardens, arboretums, and agricultural research stations.

By mandating that recovery plans give specific consideration to captive breeding and propagation, Congress could encourage links between separate programs. The approach could be broadened to encourage cooperative efforts between public and private organizations working offsite and onsite to conserve ecosystem and genetic diversity. A model for such efforts exists in the emerging cooperation between the Center for Plant Conservation (network of regional botanic institutions) and NSSL.

Option 4.3: Establish programs to fill gaps in current efforts to maintain biological diversity.

One of the most obvious gaps in domestic programs is the lack of a formal national program to maintain domestic animal genetic resources. *Congress could establish a program to coordinate activities for animal germplasm conservation, thereby reducing duplication and encouraging complementary actions.* Such a program could be established through clarification of the Agricultural Research Service mandate. An animal program could parallel the National Plant Germplasm System, but other structures should be explored as well. Alternatively, a separate program established to be semi-independent from government agencies might serve a greater variety of interests. The best structure for such a program is at present unclear.

A congressional hearing could be held to identify the main issues in establishing an animal germplasm program and to discuss alternative structures and scope of such a program.

Coordination of international efforts is also needed to preserve the diversity of agriculturally important animals. Some efforts have already been made, and the concept of an international program is gaining support. *Congress could encourage the establishment of an International Board for Animal Genetic Resources (IBAGR).* This program could par-

allel the International Board for Plant Genetic Resources (IBPGR). An IBAGR could set standards and coordinate the exchange and storage of germplasm between countries and address related issues such as quarantine regulations. It could foster onsite management of genetic resources for both minor and major breeds.

Another major gap is protection of U.S. ecosystem diversity. Numerous types of ecosystems, such as tall grass prairie, are not included in the Federal public lands system. *Congress could direct Federal land-managing agencies to include representative areas of major ecosystems in protected areas.*

One vehicle for this is the Research Natural Area (RNA) system. Since 1927, the RNA system, with the cooperation of multiple Federal agencies and private groups, has developed the most comprehensive coverage of natural ecosystem types in the United States. RNAs, however, are small scale and are mainly established on land already in public ownership. Therefore, the RNA system, may not be able to cover the major ecosystems without some additional mechanism to acquire land not already in the Federal domain, possibly through land exchanges. Nevertheless, *Congress could recognize the RNA system as a mechanism and direct agencies to work toward filling the program gaps.*

Enhance the Knowledge Base

Developing effective strategies to maintain diversity depends on knowing the components of biological systems and how they interact. Information on the status and trends in biological systems is also needed for public policy. The first step in developing such information is fundamental descriptions of the various components—species, communities, and ecosystems. Data can then be analyzed to determine how best to maintain biological diversity. More specifically, baseline data are needed for the following activities:

- assessing the abundance, condition, and distribution of species, communities, and ecosystems;
- disclosing changes that may be taking place;
- monitoring the effectiveness of resource management plans once they are implemented; and
- determining priorities for areas that merit special efforts to manage natural diversity that would benefit from protection, and that deserve particular attention to avoid biological disruption or to initiate mitigative actions.

To be effective and efficient, the acquisition, dissemination, and use of data must proceed within the context of defined objectives. For the most part, biological data used in diversity maintenance programs has been acquired without the direction of a coordinating goal. Not surprisingly, these data are widely scattered and generally incompatible. Geographical and taxonomical data gaps exist. Some taxonomic groups are ignored in field inventories, while others, particularly plants and animals with economic or recreational value, are monitored extensively. Finally, there is little data on the social, economic, and institutional

pressures on biological diversity. Consequently, available data cannot be used easily in decisionmaking directed at maintaining biological diversity.

FINDING 5: Congress and other policymakers need improved information on biological diversity. Such information cannot be supplied without improvements in data collection, maintenance, and synthesis.

Policymakers need comprehensive information on the ramifications and scope of diversity loss. Information provided by the scientific community should be a basis for resource policy and management decisions. To serve in the context of public policy, data should satisfy four criteria:

1. The data must be of *high quality*; that is, it must meet accepted standards of objectivity, completeness, reproducibility, and accuracy.
2. The data must have *value*; that is, it must address a worthwhile problem.
3. The data must be *applicable*; that is, it must be useful to decisionmakers responsible for making policy.
4. The data must be *legitimate*; that is, it must carry a widely accepted presumption of accuracy and authority.

Much information is already available but not in an assimilated form useful to decisionmakers. Data on the status and trends of biological diversity are scattered among Federal, State, and foreign agencies and private organizations. Consolidation of these data is necessary to identify gaps, to provide a comprehensive understanding of the status of the Earth's biota, and especially to define priorities for action.

Option 5.1: Establish a small clearinghouse for data on biological diversity.

The purpose of a clearinghouse would be to coordinate data collection, synthesis, and dissemination efforts. It could serve government agencies, private organizations, corporations, and individuals. The clearinghouse could perform the following functions:

- survey and catalog existing Federal, State, private, and international databases on biological resources;
- evaluate the quality of databases;
- provide small grants and personnel support services to strengthen existing databases; and
- publish annual reports on the status and needs of the biological data system.

Success in these endeavors would accelerate progress toward several objectives:

1. setting of priorities for conservation action;
2. monitoring trends;
3. developing an alert system for adverse trends;
4. identifying gaps and reviewing needs to fill them;

5. facilitating development of environmental impact assessments; and
6. evaluating options, actions, and successes and failures.

As a data-coordinating body, the clearinghouse could guide efforts to collect data on biological diversity, which will provide a comprehensive perspective that Federal agencies cannot supply because of their varied mandates. Access to previously inaccessible data would be facilitated, which should reduce duplication of efforts. By evaluating the quality of information, the clearinghouse could help eliminate a general distrust among users of other databases. Access to a diversity of databases means that no standardized system is forced on data users, which has been a formidable obstacle to database integration and use.

The clearinghouse *would not necessarily* maintain its own primary database. Commercial databases in the public domain could be included in the system, and proprietary and other limited-access databases could be reviewed regularly, with permission. Database enhancements to cover gaps could be funded by small grants. The clearinghouse's information systems could be made available through a library service and special searches. It could charge appropriate fees for all its services.

The same clearinghouse could assess information on biological diversity in international databases. It could provide a small amount of financial and personnel aid to help international organizations improve their databases. In addition, it could work with development assistance agencies to support the participation of other countries' national databases in such international and regional networks as the International Union for the Conservation of Nature and Natural Resources Conservation Monitoring Center, the United Nations Educational, Scientific, and Cultural Organization's (UNESCO) Man and the Biosphere Program (MAB), and The Nature Conservancy International.

Possible objections to such a clearinghouse include the following: 1) that lack of a uniform system of data collection for the United States would hinder national data analysis and use, and 2) that evaluating the quality of other agencies' databases would be politically sensitive. Questions such as the size, administrative structure, and cost of a clearinghouse program must be answered as well. Because it would not maintain its own primary database, however, such a clearinghouse would not need to be a large-scale operation.

Option 5.2: Provide funding to enhance the existing network of natural heritage conservation data centers.

A number of state governments, aided by The Nature Conservancy (TNC), have already established a network of Natural Heritage Data Centers in many States and in some foreign countries. These centers collect and organize biological data specifically for diversity conservation. All centers use a standardized format to collect and synthesize data. The result has been a vehicle to exchange and to aggregate information about what is happening to biological resources at State and local levels and, more recently, around the Nation and across the Western Hemisphere.

Funding for these data centers comes from a combination of Federal, State, and private (including corporate) sources. Progress has been limited, however, by the amount of available funds. *Congress could enhance these efforts by providing a consistent source of additional funding.* By increasing support for the Federal-State-private partnership, the action by Congress could reinforce the application of standard methods, enhance interagency compatibility, improve the efficiency of biological data collection and management, and facilitate the free exchange of useful information. Moreover, the partnership could accelerate the rate at which data centers spread to the remaining States and nations.

An appropriation of $10 million per year, for example, could be divided among several data center functions: supporting central office activities in research, development, documentation, and training; conducting taxonomic work; and matching grants from States and other participants. One source of funding could be the Land and Water Conservation Fund. Although this fund is used mainly for land acquisition, it could also support preacquisition activities such as identification of lands to be acquired. Data centers are key to such activities.

This option does not necessarily replace the need for an information clearinghouse because diverse databases and information systems will continue to operate. The two options could be complementary. Some clearinghouse functions might be handled by TNC, but others, such as facilitating improvement of and access to data sources, could be best handled by a separate entity that functions much like a library.

Support International Initiatives To Maintain Biological Diversity

Most biological resources belong to individual nations. However, many benefits from diversity accrue internationally. American agriculture, for example, depends on foreign sources for genetic diversity to keep ahead of constantly evolving pests and pathogens. And many bird populations important to controlling pests in the United States overwinter in the forests of Latin America.

Solutions to problems that cause diversity loss must be implemented locally, but many of these will be effective only if supported by international political and technical cooperation. Examples of such problems include the international trade in rare wildlife, the greenhouse effect of carbon dioxide on the climate, the effects of acid rain on freshwater lakes and forests, and damage to oceans by pollution and overfishing. The United States has the political prestige needed to initiate international cooperation, and it leads the world in much of the technical expertise needed, such as fundamental biology and information processing. Thus, the United States has both motive and ability to participate and to provide leadership in international conservation efforts.

The United States has historically played a leading role in promoting international conservation initiatives, and precedence exists for extending this leadership to an international or global approach for conserv-

ing biological diversity. A variety of international conventions and multilateral programs already specify biological diversity as an aspect of broader conservation objectives (e.g., biosphere reserve program). Such internationally recognized obligations can be important policy tools in concert with technical, administrative, and financial measures to encourage programs for conserving diversity. Obligations confirmed by international conventions provide conservation authorities with the justification frequently needed to strengthen their national programs.

FINDING 6: The United States has begun to abdicate leadership in international conservation efforts, with the result that international initiatives are weakened or stalled in the tropical regions where diversity losses are most severe. Renewed U.S. commitment could accelerate the pace of international achievements in conservation.

The United States has been a model and an active leader in international conservation activity. The movement toward establishment of national parks worldwide grew out of the United States. In the early 1970s, the United States was a leader in international environmental and resource deliberations, notably in the 1972 UN-sponsored Stockholm Conference on the Human Environment. U.S. leadership, for example, played an important role in establishing the United Nations Environment Programme (UNEP), and in securing the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the World Heritage Convention, all important foundations of current international efforts to support maintenance of biological diversity.

However, U.S. support for these kinds of initiatives has declined. The retrenchment in support reflects austerity measures as well as dissatisfaction with the performance of specific international organizations. Effective international projects, such as UNESCO's Man and the Biosphere Program, have suffered by association.

U.S. support of international conservation efforts is pivotal in that the United States has greater resources and stronger technical abilities than most other countries to address the complex issue of diversity loss. Without greater initiative and access to resources, many countries will be unable to arrest loss of diversity within their borders. Under existing conditions, countries that harbor the greatest diversity are expected to devote a large part of their national resources to address the problem, even though benefits commonly extend beyond their countries. It would seem equitable for those countries that benefit, including the United States, to share more fully in efforts to conserve diversity in countries otherwise unable to do so.

Option 6.1: Sustain or increase support of international organizations and conventions.

International conservation initiatives are important tools for long-term conservation of biological diversity. Yet, existing international agreements are often poorly implemented because of lack of adequate administrative machinery (e.g., adequately funded and staffed secre-

tariats), lack of financial support for on-the- ground programs (e.g., equipment, training, and staff), and lack of reciprocal obligations that could serve as incentives to comply.

An exception is CITES, which has mechanisms to facilitate reciprocal trade controls and a technical secretariat. The existence of this machinery in large part accounts for the relative success of this convention. The United States has been globally influential in supporting CITES and has reinforced it through national legislation that prohibits import into the United States of wildlife taken or exported in violation of another country's laws. The amendment to the Lacey Act of 1900 (Public Law 97-79) in 1981 backs efforts of other nations seeking to conserve their wildlife resources. This law has been a powerful tool for wildlife conservation throughout the world because the United States is a major importer of wildlife specimens and products.

U.S. contributions to international conservation programs have been diminishing recently. The appropriation cycle for funding such programs has been an annual tug-of-war between Congress and the Administration. The budget of the World Heritage Convention in 1985 was $824,000. The United States, one of the major forces behind the Convention's founding, usually contributes at least one-fourth of the budget. U.S. contributions averaged $300,000 in the fiscal years of 1979 to 1982. From fiscal year 1982 to 1984, the United States made no contributions, but contributed $238,903 in fiscal year 1985. In fiscal year 1986, $250,000 had been appropriated, but the amount was cut to $239,000 under Gramm-Rudman-Hollings Balanced Budget and Emergency Deficit Control Act.

Congress could maintain or increase U.S. support of international organizations and programs in several ways. *Congress could ensure that these organizations receive adequate annual appropriations and could conduct oversight hearings to encourage the Administration to carry out the intent of Congress.*

One possible drawback associated with contributions to international intergovernmental organizations is their lack of accountability. Compared to bilateral assistance channels, the United States has little control over how or to whom intergovernmental organizations direct their resources. The consequence is that U.S. funds go to countries that are unfriendly or even adversarial to the United States and its policies.

It should be recognized, however, that many international activities specific to maintenance of biological diversity, especially activities of UNEP, UNESCO-MAB, and IBPGR, operate largely within scientific channels, which tends to reduce the political overtones inherent in intergovernmental organizations. Also, objectivity can be enhanced in programs willing to establish protocols. For example, establishing criteria to determine which areas qualify for biosphere reserve status or which unique areas warrant (natural) World Heritage status provides objectivity in directing resources.

Congress could also encourage or direct Federal agencies to assign technical personnel to international organizations or to the secretariats of the various conventions. This option could be difficult to imple-

ment without legislating special allowances for agency personnel ceilings and budgets. Otherwise, agencies will be reluctant to assign personnel overseas in light of a shrinking Federal work force and budget.

Option 6.2: Continue to direct U.S. directors of multilateral development banks (MDBs) to do the following: 1) press for more specific and systematic MDB efforts to promote sound environmental and resource policies akin to the World Bank's wildland policy, 2) work to make projects consistent with international and recipient country environmental policies and regulations, and 3) seek to involve recipient country environmental officials and nongovernmental organizations in project formulation processes.

A significant part of all international development assistance efforts are funded by the World Bank and regional MDBs. Thus, these organizations are uniquely situated to influence environmental aspects of development, including the maintenance of biological diversity. In fact, the MDBs' priorities and policies can be the single most important influence on the development model adopted by developing countries. MDB agricultural, rural development, and energy programs all have profound effects on biological resources in developing countries.

The World Bank promulgated a new policy in 1986 on the treatment of wildlands in development projects. The bank recognizes that although further conversion of some natural land and water areas to more intensive uses will be necessary to meet development objectives, other pristine areas may yield benefits to present and future generations if maintained in their natural state. These are areas that, for example, may provide important environmental services or essential habitats to endangered species. To prevent the loss of these wildland values, the policy specifies that the Bank will normally decline to finance projects in these areas and instead prefer projects on already converted lands. Conversion of less important wildlands must be justified and compensated by financing the preservation of an ecologically similar area in a national park or nature reserve, or by some other mitigative measures. The policy provides systematic guidance and criteria for deciding which wildlands are in need of protection, which projects may need wildland measures, and what types of wildland measures should be provided.

In 1980, the World Bank, Inter-American Development Bank, Asian Development Bank, and six other multilaterals signed a "Declaration of Environmental Policies and Procedures Relating to Economic Development," and formed the Committee on International Development Institutions on the Environment (CIDIE), under the auspices of the United Nations Environment Programme. The agencies agreed to systematic environmental analysis of activities funded for environmental programs and projects. However, a subsequent study found that these policy statements by the MDBs were not effectively translated into action. Criticisms of how well MDBs implement environmental policies remain strong. And it is too soon to determine the effectiveness of the World Bank's wildland policy.

The United States is limited in its ability to effect change at MDBs because the banks are international institutions run collectively by member nations. Since the United States is a large contributor, however, it does have considerable influence on bank policies, which are determined by boards of directors.

The primary way Congress affects policies of these banks is by requesting that the U.S. executive directors—who are responsible to the Secretary of the Treasury—carry out congressionally approved policies. These requests may be made at oversight hearings or in the language of appropriation legislation. For instance, the 1986 House Committee on Appropriations Report stated guidelines for the U.S. executive directors (Sec. 539), which included the addition of relevant staff, development of management plans, and commitment to increase the proportion of programs supporting environmentally beneficial projects. To continue this guidance, *Congress could require the U.S. executive directors of MDBs to encourage the adoption of a policy similar to the World Bank's wildlands policy statement.*

FINDING 7: Constraints on international exchange of genetic resources could jeopardize future agricultural production and progress in biotechnologies. Such constraints are becoming more likely because developing countries with sovereignty over most such resources believe that the industrial nations have benefited at their expense. Debates on the issue could benefit from a more informed and less impassioned approach.

All countries benefit from the exchange of genetic resources. Many of the major crops currently grown in various countries have originated elsewhere. Coffee, for example, is native to the highlands of Ethiopia. Yet, today, it represents an important source of income for farmers in other parts of Africa, Asia, and Latin America. Maize, originally from Central America, is grown as a staple crop in North America and Africa. Countries continue to depend on access to germplasm from outside their borders to maintain or enhance agricultural productivity. Political and economic considerations, however, are now prompting national governments to restrict access to their germplasm. Behind these efforts is an implicit desire by some countries to obtain greater compensation for the genetic resources that are currently made freely available.

The International Board for Plant Genetic Resources (IBPGR) is the main international institution dealing with the offsite conservation of plant genetic diversity. Established in 1974, it promotes the establishment of national programs and regional centers for the conservation of plant germplasm. It has provided training facilities, carried out research in techniques of plant germplasm conservation, supported numerous collection missions, and provided limited financial assistance for conservation facilities. However, it does not operate any germplasm storage facilities itself.

Due in part to the success of IBPGR in focusing attention on the need to conserve genetic diversity, the issue of germplasm exchange has be-

come embroiled in political controversy. Some critics regard the IBPGR as implicitly working for agribusiness interests of industrial nations. Central to the issue is a perception on the part of many developing countries that they have been freely giving genetic resources to industrial nations which, in turn, have profited at their expense.

This controversy led the United Nations Food and Agricultural Organization (FAO) to sponsor an International Undertaking on Plant Genetic Resources. The undertaking proposed an international germplasm conservation network under the auspices of FAO. It declared that each nation has a duty to make all plant genetic materials—including advanced breeding materials—freely available. IBPGR was to continue its current work, but it would be monitored by FAO.

FAO then established the Commission on Plant Genetic Resources to review progress in germplasm conservation. The commission held its first meeting in March 1985, with the United States present only as an observer. Much of the discussion focused on the concerns expressed in the undertaking and on onsite conservation.

The continuing controversy includes charges that the current international system enables countries to restrict access to germplasm in international collections for political and economic reasons. Also of concern to some parties is the impact of plant patenting legislation.

Current charges and arguments in the FAO forum tend to oversimplify the complexity of how germplasm is incorporated into plant varieties and to distort the actual nature of genetic exchange between and among industrial and developing countries. Restrictions on export of germplasm, for example, appear to be more common for developing countries. Nevertheless, the perception of inequity in the current situation is real, and it could result in increasing national restrictions on access to and export of germplasm. Further, the issue of control over genetic resources could become a significant stumbling block to establishing international commitment and cooperation in the maintenance of overall biological diversity.

Option 7.1: Closely examine the actions available to the United States regarding the issue of international exchange of genetic resources.

Efforts to address the conservation and exchange of plant genetic resources in the FAO forum have been controversial. It is not yet apparent how the United States should act in this regard. Congress could give increased attention to determining what options are available.

One possible action is for Congress to request that an independent organization, such as the National Academy of Sciences, study this issue. In fact, NAS has already indicated interest in investigating this as a part of its current 3-year study of global genetic resources . Such a study could draw on other agencies and individuals with interest and expertise in this area to define several general actions the United States might take in regard to international exchange of genetic resources and the consequences associated with it.

Another option is to favor the status quo, ignoring the criticisms and avoiding the risk that new political actions might disrupt effective scientific working arrangements. A practical international flow of germplasm is likely to continue in the future, with or without the formal international arrangements envisioned by the FAO undertaking. In time, the political issues may be resolved equitably without pushing nations into conflicts over breeders' rights or access to genetic materials.

Another possibility would be for the United States to associate with the FAO Commission on Plant Genetic Resources. U.S. influence might strengthen the international commitment to free flow of germplasm and reduce the risk that germplasm will increasingly be withheld for political or economic reasons.

Unless Congress chooses to restrict plant breeders' rights in the United States, the U.S. Government will be unable to join the undertaking without major reservations. Such a change in domestic law seems politically unlikely, given domestic benefits provided by plant breeders' rights and the effective lobbying efforts of the seed industry. However, the United States could consider renegotiating the FAO undertaking to require a commitment to grant global access to genetic resources—with appropriate exceptions for certain privately held materials—within the context of an internationally supported commitment to help countries conserve and develop their genetic resources. Parallel agreements also might be developed for domestic animal, marine, and microbial resources. Such agreements could also define national and international obligations to collect and conserve the germplasm that is being displaced by new varieties or by changing patterns of agricultural developments.

Finally, U.S. representatives could consider promoting a discussion of genetic resource exchanges outside formal channels in an effort to separate the technical issues from emotional ones. The Keystone Center, an environmental mediation organization, is exploring the possibility of conducting a policy dialog on this topic in the near future.

Option 7.2: Affirm the U.S. commitment to the free flow of germplasm through an amendment to the Export Administration Act.

Specific allegations have been made that the United States has restricted the access to germplasm in national collections (at the National Plant Germplasm System) for political reasons. The government, however, maintains that it adheres to the principles of free exchange.

To reinforce recent executive affirmations of the free flow of germplasm, *Congress could exempt the export of germplasm contained in national collections from Export Administration Act restrictions or political embargoes imposed for other reasons.* Comparable provisions are already included in this act with respect to medicine and medical supplies (50 U.S.C. app. sec. 2405 (g), as amended by Public Law 99-64, July 12, 1985). Because this germplasm is already accessible through existing mechanisms, such a provision would only reaffirm the U.S. position and remove from the current debate the allegations of U.S. restrictions of access to germplasm.

On the other hand, the process of amending the act may generate support for restricting germplasm—by excluding certain countries from such an exemption. Restricting access in such a manner would likely lead to an international situation counter to U.S. interests. In such a case, no action would be preferable to an amendment.

Address Loss of Biological Diversity in Developing Countries

The United States has a stake in promoting the maintenance of biological diversity in developing countries. Many of these nations are in tropical regions where biological systems are highly diverse, where pressures that degrade diversity are generally most pronounced, and where the capacity to forestall a reduction in diversity is least well-developed. The rationale for assisting developing countries rests on: 1) recognition of the substantial existing and potential benefits of maintaining a diversity of plants, animals, and microbes; 2) evidence that degradation of specific ecosystems is undermining the potential for economic development in a number of regions; and 3) esthetic and ethical motivations to avoid irreversible loss of unique life forms.

The U.S. Congress, recognizing these interests, passed Section 119 of the Foreign Assistance Act of 1983, specifying conservation of biological diversity as a specific objective of U.S. development assistance. The U.S. Agency for International Development (AID), as the principal agency providing development assistance, was given a mandate to implement this policy, which reads in part:

> In order to preserve biological diversity, the President is authorized to furnish assistance to countries in protecting and maintaining wildlife habitats and in developing sound wildlife management and plant conservation programs. Special effort should be taken to establish and maintain wildlife sanctuaries, reserves, and parks; to enact and enforce anti-poaching measures; and to identify, study, and catalog animal and plant species, especially in tropical environments.

A review of AID initiatives since 1983 suggests that despite the formulation of a number of policy documents, the agency lacks a strong commitment to implementing the specific types of projects identified in Section 119. This lack of commitment is due to several factors, including: 1) a belief that the agency is already addressing biological diversity to the extent it should, 2) reduced levels of budgets and staff to initiate projects, and 3) an inadequate number of trained personnel to address conservation concerns generally.

Several questions arise in relation to the capacity and the appropriateness of U.S. commitments to support diversity conservation efforts through bilateral development assistance. First, it is unclear whether Section 119, as the principal legislation dealing with concerns over diversity loss outside the United States, defines U.S. interests too narrowly. Second, it is uncertain how Section 119 relates to the principal goals of foreign assistance, as specified in section 101. Finally, questions remain concerning the commitment of resources and personnel to address U.S. interests in maintaining diversity in developing countries.

FINDING 8: Existing legislation may be inadequate and inappropriate to address U.S. interests in maintaining biological diversity in developing countries.

Maintaining diversity will depend primarily on onsite maintenance. The "special effort" initiatives identified in Section 119 are important components of a comprehensive program. What is not clear, however, is whether the emphasis is appropriate within the context of U.S. bilateral development assistance. That is, establishing protected areas and supporting anti-poaching measures can have adverse impacts on populations that derive benefits from exploiting resources within a designated area. These populations are characteristically among the "poorest majority" intended to be the principal beneficiaries of U.S. development assistance (Sec. 101). However, demands of local populations (e.g., for fuelwood or agricultural land) may threaten diversity and even the sustainability of the resource base on which they depend. It does, however, raise questions on the appropriateness of supporting activities that could place increased stress on these populations.

Second, existing legislation identifies concern over diversity loss separately from conversion of tropical forests and degradation of environment and natural resources (Sec. 118 and 117, respectively). Clearly, these concerns are interrelated, although not synonymous. It is questionable whether such a distinction is appropriate within the context of development assistance legislation. An argument can be made that U.S. development assistance should approach diversity maintenance within the context of conservation—that is, as a wise use of natural resources, as elaborated in the World Conservation Strategy. In doing so, the objectives of diversity maintenance and development interests could be made more compatible.

Finally, although Section 119 speaks of biological diversity, the thrust of the legislation addresses a narrower set of concerns—that of species extinction. While certainly a prominent concern, and perhaps even the central motivation behind the legislation, it fails to address the broader set of U.S. concerns over diversity loss in developing countries. As noted earlier, a focus on unique populations would be a more appropriate, though more problematic, approach. This is particularly important with regard to preserving genetic resources of potential benefit to agriculture or industry, which is the most strongly argued rationale for conserving biological diversity. Existing legislation does not specifically identify these interests.

Option 8.1: Restructure existing sections of the Foreign Assistance Act to reflect the full scope of U.S. interests in maintaining biological diversity in developing countries.

The U.S. Foreign Assistance Act (FAA) comes up for reauthorization in 1987. Major restructuring of the act is already being considered. Revamping could provide an opportunity to recast certain provisions of the legislation to better account for U.S. interests in maintaining diversity in developing countries.

Providing for conservation of natural resources and the environment in general, and of biological diversity and tropical forests in particular, are important considerations in a restructuring of FAA. Less clear, however, is whether the language and disaggregation of these interests is appropriate in the context of bilateral development assistance.

One specific consideration could be to resolve potential conflicts of interests that exist in the language of Section 119—that of emphasizing the need to establish protected areas and poaching controls without specific reference to impacts on indigenous populations. *Congress could correct this potential conflict by adding language to Section 119 such as, "Support for biological diversity projects should be consistent with the interests, particular needs, and participation of local populations."* It is widely recognized that the viability of protected areas is largely contingent on these provisions. Adding such language would thus provide greater consistency within the objectives of FAA as well as specify criteria that heighten chances of project success.

In addition, *Congress could recast the language of existing legislation to provide a fuller accounting of U.S. interests in maintaining diversity in developing countries.* Such changes could expand from a focus on endangered species to the loss of biological systems, including ecosystems and genetic resources. Such an effort might also emphasize practical aspects of conservation initiatives of particular interest to developing countries and stress the goal of promoting ability and initiatives of the countries themselves.

Finally, *Congress could combine those sections of FAA that deal with natural resources and environmental issues to reflect the interrelatedness of these amendments.* Provisions could be made to account for specific concerns over species extinctions currently emphasized in Section 119. But approaches and concerns reflected in these amendments are probably best considered together. Provision of funding within such a restructuring would also be important.

FINDING 9: AID could benefit from additional strategic planning and conservation expertise in promoting biological diversity projects.

Congress has already taken steps to earmark funds for biological diversity projects within AID's budget. The existing mechanisms within the agency to identify and promote diversity projects are not well established, however. Because funding is minimal, it is all the more important to devise a strategy that allows priority initiatives to be defined.

Environmental expertise within AID is slim. In recent years, in-house expertise in this area has declined, and that which does exist has been severely overextended. Addressing biological diversity will, therefore, require both increasing the number of AID staff with environmental training and an increased reliance on expertise outside AID, in other government agencies and in the private sector. AID has already taken steps to cultivate this environmental expertise, but further actions could be taken.

Option 9.1: Direct AID to adopt a more strategic approach in promoting initiatives for maintenance of biological diversity.

The *U.S. Strategy on the Conservation of Biological Diversity: An Interagency Task Force Report to Congress* was delivered to Congress in February 1985, in response to provisions in Section 119. A general criticism of the document was that although it contained 67 recommendations, it lacked any sense of priority or indication of funding sources to undertake these recommendations. In an attempt to apply the recommendations to specific agency programs, AID drafted an *Action Plan on Conserving Biological Diversity in Developing Countries* (January 1986). Comments received from AID overseas suggest that problems exist in translating the general principles and recommendations of an agency plan into specific initiatives at the country level.

A more refined approach to addressing diversity interests within the agency may be required. Such an approach would seek to incorporate biological diversity concerns into AID development activities at different levels of the agency, ranging from general policy documents at the agency level to more strategic efforts at the regional bureau and mission levels.

At least two efforts could be considered at the agency level. First, *Congress could direct AID to prepare a policy determination (PD) on biological diversity*. A PD would serve as a general statement that maintaining diversity is an explicit objective of the agency. In developing a PD, AID should review provisions contained in the recent World Bank wildlands policy statement.

Existence of a PD could mean that consideration of diversity concerns would, where appropriate, become an integral part of sectoral programming and project design. Further, it would require that projects be reviewed and evaluated by the Bureau of Program and Policy Coordination for consistency with the objectives of the PD. Because of the increase in bureaucratic provisions this would create, the formulation of a PD on diversity probably would not be well received within AID.

A second effort is to establish a centrally funded project within AID's Bureau of Science and Technology. AID has already developed a concept paper along these lines as a prelude to a more concrete project identification document. As conceived, the concept paper examines the possibility of establishing a biological diversity project. One major benefit of such a project would be the establishment of a focal point for coordinating funding and technical assistance on biological diversity. The Science and Technology Bureau's emphasis on technical assistance, research, training, and institutional development would make it the appropriate bureau for such a program. A constraint to this approach is that biological diversity projects may continue to be separate rather than an integral part of development programs.

The three regional bureaus of AID (i.e., Africa, Asia and Near East, and Latin America and the Caribbean) could also prepare documents that identify important biological diversity initiatives in their regions. The Asia and Near East Bureau, in fact, has already prepared such a

document that could be used in highlighting regional priorities. A reluctance to direct scarce funds to diversity projects, at the expense of more traditional development projects, has limited the utility of the document to date. Nevertheless, the development of such reports for each regional bureau is considered an effective way to identify priorities for existing diversity projects, especially given the earmarking of funds.

The most important focus of biological diversity strategies is at the mission level, where projects are implemented. Congress has already mandated that Country Development Strategy Statements and other country-level documents prepared by AID address diversity concerns. Most missions, however, lack the expertise or adequate access to expertise needed to address this provision of Section 119 as amended.

Option 9.2: Direct AID to acquire increased conservation expertise in support of biological diversity initiatives.

The ability of AID to promote biological diversity in developing countries is seriously undermined by its lack of personnel trained in environmental sciences. While true at the agency headquarters, the problem is particularly acute in its overseas missions. Although AID designates an environmental officer at each mission, the person usually has little professional experience or training in the area. Often environmental duties are combined with numerous other duties; few AID personnel are full-time environmental officers. Under these circumstances, it is difficult to envision how AID can effectively promote biological diversity maintenance.

Congress could direct AID to recruit and hire additional personnel with environmental science backgrounds or at a minimum provide increased training for existing staff. The near-term prospects for AID, however, point to a reduction in an already overworked staff. It seems unlikely, therefore, that significant in-house conservation expertise will be developed. Consequently, addressing biological diversity within AID will depend on providing access to conservation expertise within other government agencies and in the private sector. Even drawing on outside expertise, AID will need some increase in environmental officers to manage and coordinate projects.

AID already draws on other government agencies to participate in projects supporting biological diversity maintenance. Mechanisms such as Participating Agency Service Agreements (PASA) and Resource Services Support Agreements (RSSA) allow interagency exchanges of experts and services. AID currently has a RSSA with Fish and Wildlife Service for the services of a technical advisor to handle biological diversity issues. These mechanisms could be used to facilitate further access to conservation experts in other government agencies.

A biological diversity program could be established within the existing Forestry Support Program, for example. The Forestry Support Program is an RSSA between AID and the U.S. Department of Agriculture (USDA) to provide technical assistance to AID in the area of forestry and natural resources. A diversity program would likely be an RSSA

between AID, the Department of the Interior, and USDA. Such a program would provide AID missions with access to conservation expertise within the Department of the Interior, the USDA, and through a roster of consultants.

A constraint to the RSSA and PASA is agency personnel ceilings and the limited number of personnel with international experience. In light of a reduction of the Federal work force, agencies may be reluctant to devote their staff to nonagency projects. Although some Federal programs have been successfully used in supporting AID projects, expertise within the private sector will also be needed to address AID's requirements.

The Peace Corps is also seen as having special potential to support biological diversity projects. Cooperative agreements with the National Park Service, Fish and Wildlife Service, The Man in the Biosphere Program, and World Wildlife Fund/U.S. have increased the Peace Corps' capacity and access to talent and training in this area. Another area of potential collaboration is between the Peace Corps and the Smithsonian Institution, especially given the Smithsonian's newly established Biological Diversity Program. Precedence exists for such a cooperative relationship, in the form of the Smithsonian-Peace Corps Environmental Program, which was terminated in the late 1970s. With the emergence of special interests in diversity maintenance, *Congress could direct both agencies to investigate re-establishing a similar initiative focused on biological diversity projects.*

Section 119 of FAA states:

> . . . whenever feasible, the objectives of this section shall be accomplished through projects managed by appropriate private and voluntary organizations, or international, regional, or national nongovernmental organizations which are active in the region or country where the project is located.

A number of nongovernmental organizations (NGOs) are already working with AID in developing capacity to maintain diversity in developing countries. These include important initiatives in the areas of conservation data centers, of supporting development of national conservation strategies, and of implementing field projects. AID is also using a private NGO to maintain a listing of environmental management experts. Such partnership could continue to be encouraged by Congress through oversight hearings, for instance. Encouraging joint public-private initiatives through matching grants should also be stressed.

FINDING 10: A major constraint to developing and implementing diversity-conserving projects in developing countries is the shortage of funds. Present funding levels are insufficient to address the scope of the problem adequately.

Recently passed legislation earmarked $2.5 million of AID's 1987 funds for biological diversity projects. Given that this amount is intended to be used to address diversity loss over three continents and is guaranteed for only 1 year, its adequacy can be questioned. Faced with prospects of further cuts in an already reduced foreign assistance bud-

get and a shift in the composition of this budget to proportionally less development and food aid in favor of military aid and economic support funds, it is difficult to see where further funding for diversity maintenance could be derived.

Option 10.1: Establish a new account within the AID budget to support biological diversity initiatives identified in the Foreign Assistance Act.

Sections 117, 118, and 119 of FAA all define congressional interest in conservation as an integral aspect of development. With the exception of the 1987 earmarking of funds for biological diversity, no formal funding source has been attached to these sections. The result is that support for conservation initiatives generally has been weak. Support has been further eroded recently because those functional accounts used for conservation projects—Agriculture, Rural Development, and Nutrition; and Energy, Private Voluntary Organization, and Selected Development Activities—have received disproportionate funding cuts.

Congress could define its support for the importance of conservation to development by establishing a separate fund, perhaps called an Environment and Natural Resources Account, that could be used by AID to support diversity maintenance activities. Concerns exist that functional accounts generally tend to reduce AID's flexibility, and consideration has even been given to eliminating them entirely. If established, however, an Environment and Natural Resources account could be used to define congressional concerns in this area. Specific earmarking for biological diversity could be considered within this new functional account.

Option 10.2: Amend the Agricultural Trade Development and Assistance Act of 1954 specifying that funds from the Food for Peace Program (Public Law 480) could be used for projects that directly promote the conservation of biological diversity.

An existing source of funds for biological diversity projects is Public Law 480 Food for Peace program. Titles I and III make commodities available at concessional rates with long-term, low-interest financing for debts incurred. Recipient countries resell the U.S. commodities and are required by contract to apply part of the currency to self-help projects agreed on between the country and the AID mission. The country can eventually cancel some of its debt by applying equivalent funds to long-term development projects. Title II provides U.S. commodities to developing countries in cases of emergency or for nutrition and development programs. This Food for Work program has conducted reforestation and resource management projects in which laborers are paid with food and with wages generated from the resale of U.S. commodities. Hence, Public Law 480 funds are already being used to finance projects that promote diversity maintenance. More could be done if *Congress amends Public Law 480 specifying that funds could be used for diversity conservation projects.*

Other existing funding mechanisms could be redirected to include funding of diversity projects. In response to funding cuts at AID, conservation groups have proposed certain ways to provide money for biological diversity projects. One such mechanism is the use of economic support funds for additional development assistance programs. Though primarily used for other purposes, economic support funds are the most flexible of AID's funds, with the fewest restrictions on their use. Therefore, *Congress could direct the General Accounting Office to examine such funding mechanisms and assess their feasibility as funding sources for maintenance of biological diversity.*

NOTE: Copies of the report "Technologies To Maintain Biological Diversity" can be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402, GPO stock No. 052-003-01058-5.

Assessments in Progress as of March 1987

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Technology and Public Policy To Enhance Grain Quality in International Trade
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